Exobiology in the Benner Research Group

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Exobiology in the Benner group approaches issues relating to the origin of life on Earth and its distribution in the cosmos from four directions (Figure): 1. Starting from simple organic molecules in the cosmos to define how RNA might have emerged prebiotically 2. Building from the present day backwards, exploiting the genomic, paleontological, and geological records to constrain the physiology and biochemistry of ancestral forms of life, 3. Defining planetary environments that might hold life (including "weird" life), and 4. Constructing artificial life in the laboratory. This talk will focus on the first two approaches, which are funded by the NASA Exobiology program. The talk will describe improved techniques for analyzing the progress of reactions that start with simple organic species in the cosmos, and generate carbohydrates in complex mixtures. The talk will then describe the application of these techniques to discover three sets of conditions where a borate-modulated formose process can generate ribose that is stabilize once formed. These results support the hypothesis that the borate-modulated formose reaction might have generated ribose and other sugars (see, for example, Weber's "sugar world" hypothesis) in a metastable form on early Earth and therefore, indirectly, the hypothesis that the first life on Earth used RNA as its genetic (and perhaps catalytic) encoded biopolymer. With respect to the second approach, the talk will focus on the use of experimental paleogenetics to understand the molecular biology behind major changes in the history of life on Earth. The most recently published study defines events near the end of the Cretaceous, just before dinosaurs went extinct and the Age of Mammals began. Through the resurrection of ancestral proteins from yeast, features of the interplay between fungi and fruits, as well as the animals that consumed them, can be better understood in the context of a "planetary systems biology."